chromosome 5

Humans normally have 46 chromosomes in each cell, divided into 23 pairs. Two copies of chromosome 5, one copy inherited from each parent, form one of the pairs. Chromosome 5 spans about 181 million DNA building blocks (base pairs) and represents almost 6 percent of the total DNA in cells.

Identifying genes on each chromosome is an active area of genetic research. Because researchers use different approaches to predict the number of genes on each chromosome, the estimated number of genes varies. Chromosome 5 likely contains about 900 genes that provide instructions for making proteins. These proteins perform a variety of different roles in the body.

Health Conditions Related to Chromosomal Changes

The following chromosomal conditions are associated with changes in the structure or number of copies of chromosome 5.

5q minus syndrome

Deletion of a region of DNA from the long (q) arm of chromosome 5 is involved in a condition called 5q minus (5q-) syndrome. This deletion occurs in immature blood cells during a person's lifetime and affects one copy of chromosome 5 in each cell. 5q- syndrome is a type of bone marrow disorder called myelodysplastic syndrome (MDS), in which immature blood cells fail to develop normally. Individuals with 5q- syndrome often have a shortage of red blood cells (anemia) and abnormalities in blood cells called megakaryocytes, which produce platelets, the cells involved in blood clotting. Affected individuals also have an increased risk of developing a fast-growing blood cancer known as acute myeloid leukemia (AML).

Most people with 5q- syndrome are missing a sequence of about 1.5 million DNA building blocks (base pairs), also written as 1.5 megabases (Mb). This region of DNA contains 40 genes. Research suggests that the loss of one copy of multiple genes in this region contribute to the features of 5q- syndrome. In particular, loss of the *RPS14* gene leads to the problems with red blood cell development characteristic of 5q- syndrome, and loss of *MIR145* or *MIR146A* contributes to the megakaryocyte abnormalities. Scientists are still determining how the loss of other genes in the deleted region might be involved in the features of 5q- syndrome and the development of AML.

cri-du-chat syndrome

Cri-du-chat (cat's cry) syndrome is caused by a deletion of the end of the short (p) arm of chromosome 5. This chromosomal change is written as 5p- (5p minus). The signs and symptoms of cri-du-chat syndrome are probably related to the loss of multiple genes in this region. Researchers are working to determine how the loss of these genes leads to the features of the disorder. They have discovered that in people with cri-du-chat syndrome, larger deletions tend to result in more severe intellectual disability and developmental delays than smaller deletions. Researchers have also defined regions of the short arm of chromosome 5 that are associated with particular features of cri-du-chat syndrome. A specific region designated 5p15.3 is associated with a cat-like cry, and a nearby region called 5p15.2 is associated with intellectual disability, small head size (microcephaly), and distinctive facial features.

Crohn disease

Several regions of chromosome 5 have been associated with the risk of developing Crohn disease. For example, a combination of genetic variations in a region of DNA on the long (q) arm of the chromosome (5q31) has been shown to increase a person's chance of developing Crohn disease. Together, these variations are known as the inflammatory bowel disease 5 (IBD5) locus. This region of chromosome 5 contains several related genes that may influence Crohn disease risk, including *SLC22A4* and *SLC22A5*.

Variations in a region of the short (p) arm of chromosome 5 designated 5p13.1 are also associated with Crohn disease risk. Researchers refer to this part of chromosome 5 as a "gene desert" because it contains no known genes; however, it may contain stretches of DNA that help regulate nearby genes such as *PTGER4*. Research studies are under way to examine a possible connection between the *PTGER4* gene and Crohn disease.

PDGFRB-associated chronic eosinophilic leukemia

Translocations involving chromosome 5 are involved in a type of blood cell cancer called *PDGFRB*-associated chronic eosinophilic leukemia. This condition is characterized by an increased number of eosinophils, a type of white blood cell. The most common translocation that causes this condition fuses part of the *PDGFRB* gene from chromosome 5 with part of the *ETV6* gene from chromosome 12, written as t(5;12)(q31-33;p13). Translocations fusing the *PDGFRB* gene with one of more than 20 other genes have also been found to cause *PDGFRB*-associated chronic eosinophilic leukemia, but these other genetic changes are relatively uncommon. These translocations are acquired during a person's lifetime and are present only in cancer cells. This type of genetic change, called a somatic mutation, is not inherited.

The protein produced from the *ETV6-PDGFRB* fusion gene, called ETV6/PDGFRβ, functions differently than the proteins normally produced from the individual genes.

The ETV6 protein normally turns off (represses) gene activity and the PDGFRβ protein plays a role in turning on (activating) signaling pathways. The ETV6/PDGFRβ protein is always turned on, activating signaling pathways and gene activity. When the *ETV6-PDGFRB* fusion gene mutation occurs in cells that develop into blood cells, the growth of eosinophils (and occasionally other white blood cells, such as neutrophils and mast cells) is poorly controlled, leading to *PDGFRB*-associated chronic eosinophilic leukemia. It is unclear why eosinophils are preferentially affected by this genetic change.

periventricular heterotopia

In a few cases, abnormalities in chromosome 5 have been associated with periventricular heterotopia, a disorder characterized by abnormal clumps of nerve cells (neurons) around fluid-filled cavities (ventricles) near the center of the brain. In each case, the affected individual had extra genetic material caused by an abnormal duplication of part of this chromosome. It is not known how this duplicated genetic material results in the signs and symptoms of periventricular heterotopia.

other cancers

Deletions in the long (q) arm of chromosome 5 frequently occur in AML and MDS. While deletions in a specific segment of chromosome 5 are associated with a form of MDS called 5q minus syndrome (described above), other deletions are related to other forms of these blood disorders. These changes are typically somatic, which means they are acquired during a person's lifetime and are present only in tumor cells.

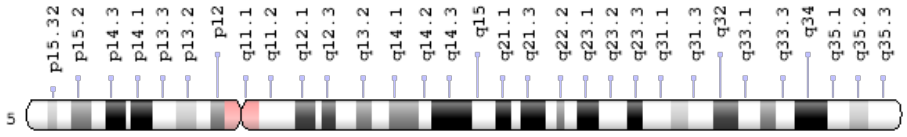
Studies suggest that some genes on chromosome 5 play critical roles in the growth and division of cells. When segments of the chromosome are deleted, as in some cases of AML and MDS, these important genes are missing. Without these genes, cells can grow and divide too quickly and in an uncontrolled way. Researchers are working to identify the specific genes on chromosome 5 that are related to AML and MDS.

other chromosomal conditions

Other changes in the number or structure of chromosome 5 can have a variety of effects, including delayed growth and development, distinctive facial features, birth defects, and other health problems. Changes to chromosome 5 include an extra segment of the short (p) or long (q) arm of the chromosome in each cell (partial trisomy 5p or 5q), a missing segment of the long arm of the chromosome in each cell (partial monosomy 5q), and a circular structure called ring chromosome 5. Ring chromosomes occur when a chromosome breaks in two places and the ends of the chromosome arms fuse together to form a circular structure.

Chromosome Diagram

Geneticists use diagrams called idiograms as a standard representation for chromosomes. Idiograms show a chromosome's relative size and its banding pattern, which is the characteristic pattern of dark and light bands that appears when a chromosome is stained with a chemical solution and then viewed under a microscope. These bands are used to describe the location of genes on each chromosome.



Credit: Genome Decoration Page/NCBI

Additional Information & Resources

MedlinePlus

- Encyclopedia: Chromosome
  https://medlineplus.gov/ency/article/002327.htm

Additional NIH Resources

- National Human Genome Research Institute: Chromosome Abnormalities
  https://www.genome.gov/11508982/

Educational Resources

- Cancer Medicine (sixth edition, 2003): Acute Myeloid Leukemia in Adults
  https://www.ncbi.nlm.nih.gov/books/NBK12754/
- Cancer Medicine (sixth edition, 2003): The Myelodysplastic Syndrome
  https://www.ncbi.nlm.nih.gov/books/NBK13629/
- Genome News Network: Human Chromosome 5 Is Complete (September 17, 2004)
  http://www.genomenewsnetwork.org/articles/2004/09/17/c5.php

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Chromosomes,+Human,+Pair+5%5BMAJR%5D%29+AND+%28Chromosome+5%5BTI%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D

OMIM

- CHROMOSOME 5q DELETION SYNDROME
  http://omim.org/entry/153550
- HETEROTOPIA, PERIVENTRICULAR, ASSOCIATED WITH CHROMOSOME 5p ANOMALIES
  http://omim.org/entry/608098
- INFLAMMATORY BOWEL DISEASE 5
  http://omim.org/entry/606348
- LEUKEMIA, ACUTE MYELOID
  http://omim.org/entry/601626

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